

**10. OBSERVATIONS OF, AND SOURCES OF THE SPATIAL AND
TEMPORAL VARIABILITY OF OZONE IN THE MIDDLE ATMOSPHERE
ON CLIMATOLOGICAL TIME SCALES (OZMAP)
AND EQUATORIAL DYNAMICS**

10.1 SEASONAL VARIATIONS OF OZONE TRENDS

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The long-term trends (least-square linear regression with time) of ozone content at seven European, seven North American, three Japanese and two tropical stations during 21 years (1964-1984) are analyzed. In all regions negative trends are observed during the 1970s, but are partly compensated by limited periods of positive trends during the late 1960s and late 1970s. Solely the North American ozone data show negative trends in all 10-year periods. When the long-term ozone trends are evaluated for each month of the year separately, a seasonal variation is revealed, which in Europe and North America has largest negative trends in late winter and spring. While in Europe the negative trends in winter/spring are partly compensated by positive trends in summer, in North America the summer values reach only zero, retaining the significant negative trend in annual mean values. In contrast to the antarctic ozone hole, the spring reduction of ozone in Europe and in North America is associated with stratospheric temperatures increasing in the analyzed period and therefore is consistent with the major natural ozone production and loss processes.

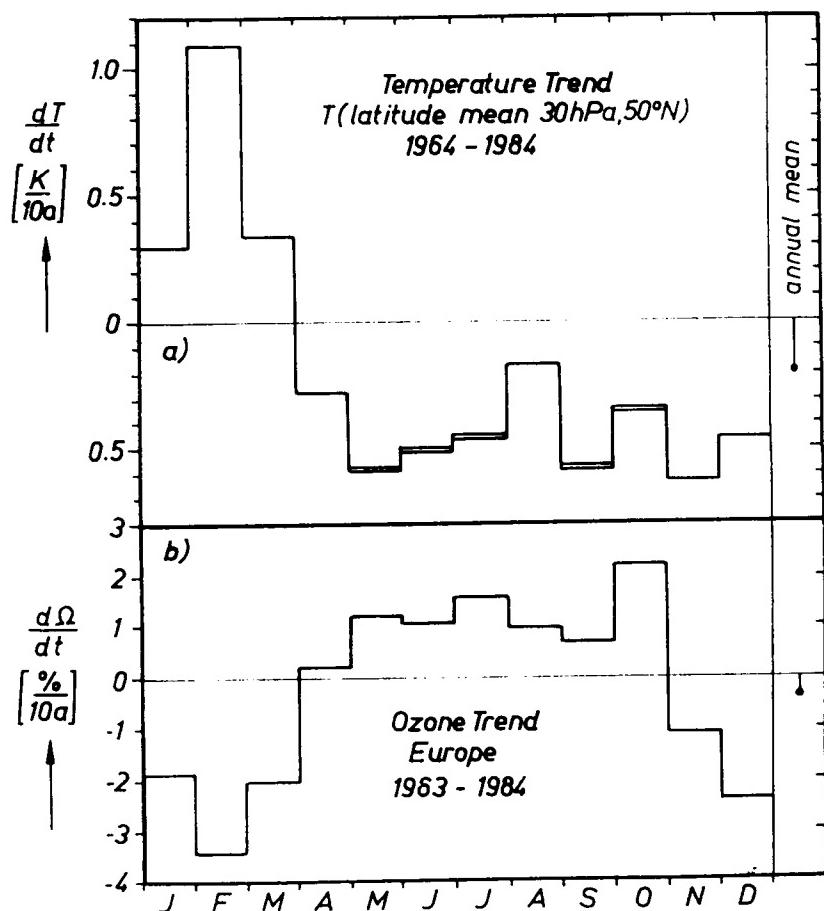


Figure 1. Seasonal trend variation: (a) Temperature trend; latitude mean 50°N , 30 hPa 1964-1984; (double lines indicate statistically significant ($>95\%$) values). (b) Trend of total ozone: mean of seven European stations 1963-1964; at right margin: trend of annual mean values over the total available time (all values in percent per 10 years). Antiphase of temperature and ozone trend (Jan - Oct) suggests the effect of normal production and loss processes, while in-phase variations (Nov - Dec) require additional processes like transport. Reactions with anthropogenic substances should be carefully considered taking into account that their interactions with dynamical processes on the Northern Hemisphere will be different from those on the Southern Hemisphere.

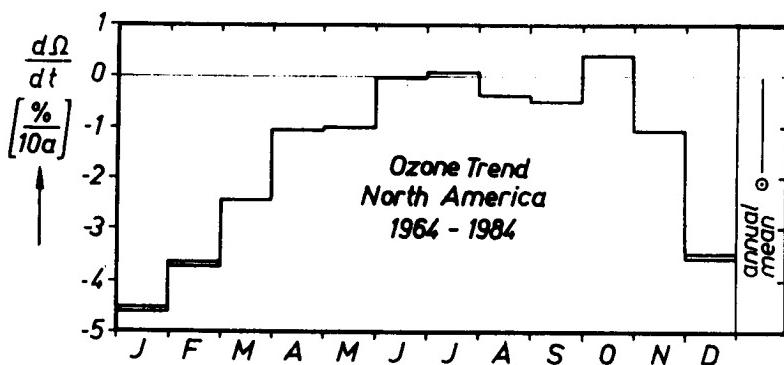


Figure 2. As Figure 1(b), but for the mean of seven North American stations. The negative trend during almost all months can possibly be explained by compensation of stratospheric ozone decrease by tropospheric ozone increase being less in North American than in Europe.

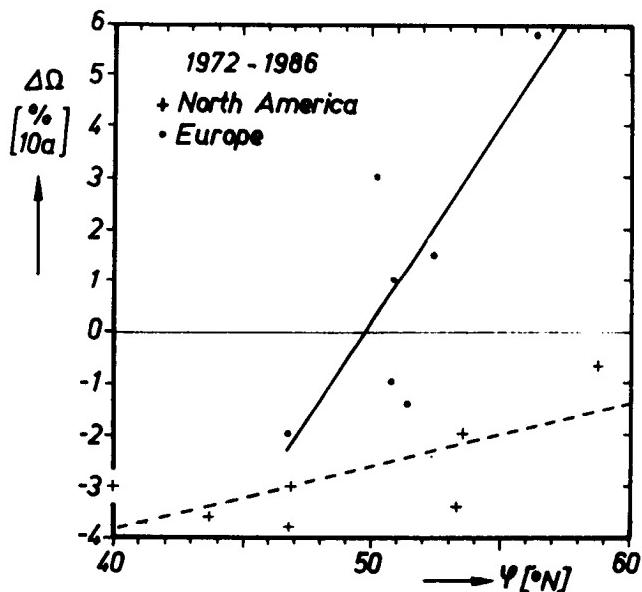


Figure 3. Latitude dependence of total ozone trend of annual mean values (1972-1986) of seven European and seven North American stations.

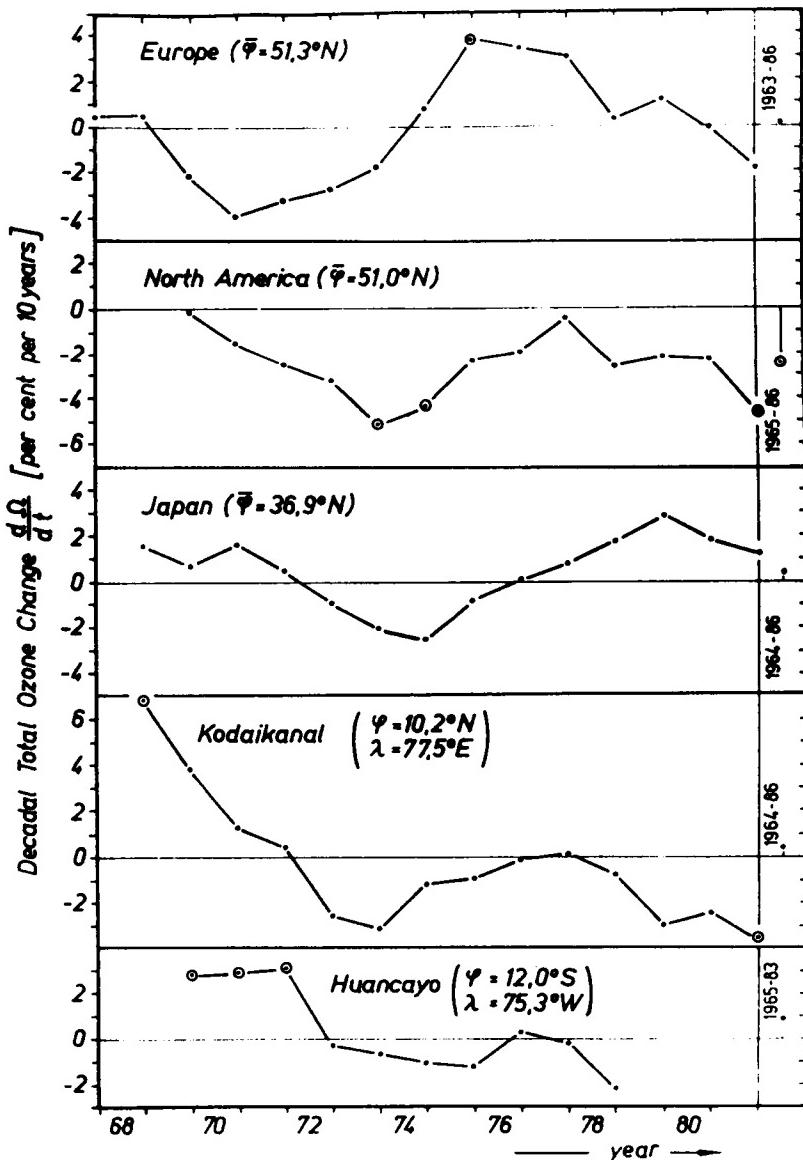


Figure 4. Time variability of trends in total ozone, from linear slopes calculated for sliding 10-year intervals in different regions. At right margin: trend over the total available period. Positive and negative trends partly compensate each other in almost all analyzed regions except North America. See Figure 2 for possible explanation. The general ozone decrease since the end of the 1970s is connected with natural processes like El Chichon eruption, El Nino / Southern Oscillation and the phase of the QBO during 1982/83.